

Surgical Revision Technique for Avascular Necrosis of the First Metatarsal Head Using Fresh Femoral Head Interpositional Allograft: A Case Study with Three-Year Follow Up

H. John Visser, DPM, FACFAS; Jesse R. Wolfe, DPM; Brittany Staples, DPM; Emily Keeter, DPM; Tyler McKee, DPM; Leslie Joseph, DPM; Jay Patel, DPM

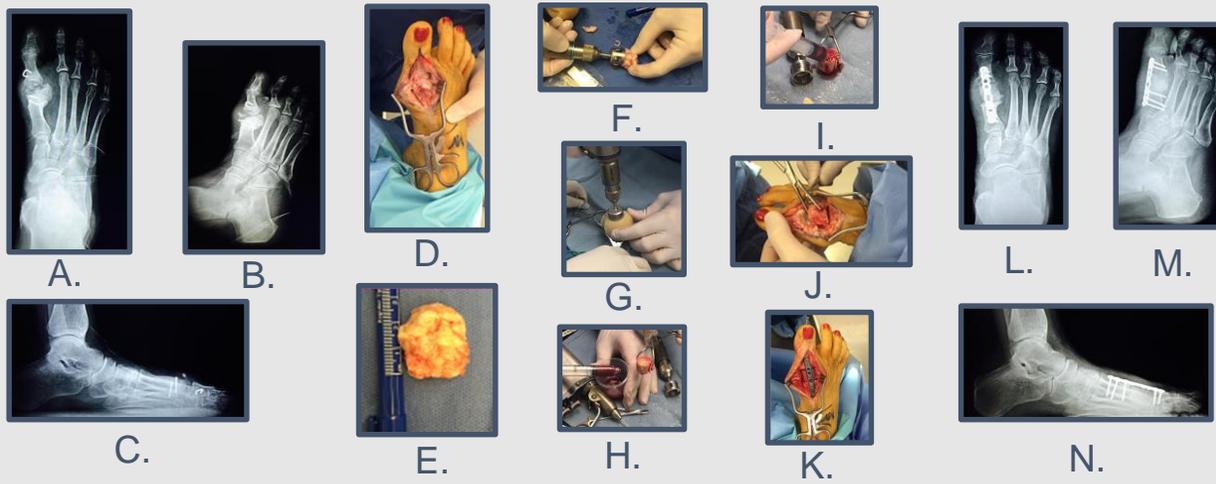
¹ Director, SSM Health DePaul Hospital Foot and Ankle Surgery Residency
² Resident, SSM Health DePaul Hospital Foot and Ankle Surgery Residency

Introduction

Avascular necrosis is among a list of iatrogenic complications following any osseous procedure. There are instances of hereditary oddities resulting in avascular necrosis within the foot; however, literature has demonstrated that the majority of these occurrences are due to various traumas sustained during a surgical procedure [1-3]. This is the often correlated to a disruption of the vascular anatomy. The blood supply of the first metatarsal was classically described by Shereff et al. (1987) and Sarrafian (1993). According to the two authors, the dorsal two-thirds of the first metatarsal head is supplied by two dorsomedial and dorsolateral metaphyseal branches while the inferior one-third is supplied by two smaller metaphyseal arteries [1-3]. In another study, Malai and colleagues evaluated the blood supply to the first metatarsal head in order to identify vessels at risk when performing a chevron osteotomy [3]. Here the authors found the plantar lateral aspect of the first metatarsal neck demonstrated the greatest ingress of vascularity to the first metatarsal head and poses risk for developing avascular necrosis should the area of vascularity become disrupted [3].

The maintenance of vascular integrity and preservation is a key component in aiding to prevent the occurrence of avascular necrosis, but other reasons are cited for the complication as well. Rothwell discusses in his evaluation of AVN, stating that bone containing high levels of yellow marrow are more susceptible pathology; likely because the hematopoietic cells of the bone marrow are particularly susceptible to ischemia which can occur in multiple forms [4]. This is the bone which is mainly cartilaginous in nature inherently has a poorer blood supply. Most obvious of the reasons for AVN are due to metatarsal osteotomy because it can distract interosseous blood-flow, especially osteotomy is performed distal to the point of penetration of the nutrient vessel of the bone. Edwards (2005) noted that excessive lateral penetration of the saw incurs a risk for severance of the dorsal metatarsal artery [5]. He also notes that even simple lateral translation of the osteotomy, stretches capsular vessels which can compromise perfusion. Additionally, any surgical procedure where the use of a power saw is in practice, exposes the patient to the risk of thermal damage of the bone which at higher temperatures results in bone death.

Treatment options for avascular necrosis of the first metatarsal head are largely dependent on whether or not the condition is symptomatic. In the presence of symptomatic avascular necrosis and radiographic evaluation. Surgical management is often recommended. Similarly, the method of treatment may also depend on the severity of the symptoms [5]. For example, a patient with mild symptomatology may benefit from joint debridement or synovectomy or subchondral drilling.



Introduction (Cont'd)

Oftentimes in AVN of the first metatarsal, anatomical length is decreased, requiring the use of either an autograft or an inter-positional allograft to restore anatomic length and function. In the presence of nonunion, autografts are preferred, however pose inherent risk to the donor site.

In the event of avascular necrosis, fresh femoral head allograft (FFHA) may be advantageous to autografts including elimination of donor site morbidity, a reduction in operative time and a low incidence of host-rejection. In the presence of severe shortening of the anatomical length secondary to AVN, the use of FFHA may prove beneficial in the restoration of both anatomical length and stability.

Case Study

A 52 year old Caucasian female, presents to clinic with chronic pain and swelling with a loss of hallux purchase. Patient has a no known allergies with an unremarkable past medical history and family history. She presents 15 months post-op from an Austin, Akin bunionectomy to the same effected foot, she was discharged 6 week post-op from that procedure.

Radiographs were obtained and erosive changes were evident in the capital fragment of the first metatarsal (A,B,C). There was elevation of the first metatarsal on lateral radiographs with dorsal calcifications. A staple was present in the proximal phalanx with 2 screw fixation present in the first metatarsal. A varus angulation at the first metatarsal phalangeal joint was noted clinically and radiographically.

Differentials included avascular necrosis and chronic osteomyelitis. Patient had no history of wound dehiscence or drainage. Further testing revealed sedimentation rate and c reactive protein were normal. The ceretec scan is equivocal for osteomyelitis; although, bone biopsy is negative for osteomyelitis. Bone cultures revealed no growth- which lead to the diagnosis of avascular necrosis of the first metatarsal head.

Surgical Technique

A month after presentation, the capital fragment was removed in the operating room (D,E). The removed metatarsal head was then sized to a bone trephine and a FFHA was obtained (F,G). Next, the allograft was fenestrated to allow it to be impregnated with bone marrow aspirate (H,I). The FFHA was then placed as an interposition graft in the first ray separating the proximal phalanx and remaining first metatarsal (J). A K wire was bent and angulated to position the graft properly.

Lastly, a locking bridge plate with inter- plate compression was utilized to maintain position of the graft (K). The plate was contoured to the hallux position. Two screws were placed distal to the allograft into the proximal phalanx and three screws placed proximal to the graft into the metatarsal (L,M,N). The surgical site was copiously irrigated with saline with deep closure prior to skin closure. Patient was then follow for 3 years postoperatively. At 3-years the patient was ambulating pain free.

Discussion

Avascular necrosis of the first metatarsal head is fairly low when using proper surgical techniques with distal first metatarsal head osteotomies. Surgical revision of the first metatarsal head is often required to prevent further collapsing and shortening of the first metatarsal head when avascular necrosis arises from the first metatarsal head. The utilization and surgical technique of fresh femoral head interpositional allograft has been presented by the authors in a three year follow up of a first metatarsophalangeal joint arthrodesis with good results.

Brosky and colleagues (2009) described a reaming technique, however used 2.5mL of bone matrix containing stem cells. A 1.5x1.0cm autogenous corticocancellous bone graft was then utilized, noting a good postoperative outcome at 14 months postoperatively[6].

In a similar technique, McCammon and colleagues (2016) described the use of a femoral head allograft in first metatarsophalangeal joint fusion using a cup and cone reamer system. The authors recommended the patient remain non-weightbearing for 10-14 weeks and found good postoperative outcomes [7].

In the presence of AVN secondary to chevron osteotomy, use of FFHA may prove beneficial in maintaining anatomical length and osseous fusion.

References

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